UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W., SUITE 2900
ATLANTA, GEORGIA 30323-0199

Report Nos.: 50-259/94-29, 50-260/94-29, and 50-296/94-29

Licensee: Tennessee Valley Authority
6N 38A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

Docket Nos.: 50-259, 50-260 and 50-296 License Nos.: DPR-33, DPR-52, and DPR-68

Facility Name: Browns Ferry Nuclear Power Station Units 1, 2, and 3

Inspection Conducted: November 1-4, 14-18, and December 5-9, 1994

Inspectors: J. J. Lenahan — Date Signed: 1/5/95

R. C. Chou (November 14-18. and December 5-9, 1994) — Date Signed: 1/5/95

Approved by: C. A. Casto, Chief
Engineering Branch
Division of Reactor Safety — Date Signed: 1/6/95

SUMMARY

Scope:

This special, announced inspection was conducted in the areas of review of design control procedures, review of audits of pipe support calculations, review of pipe support calculations, and review of licensee action on previous inspection findings.

Results:

In the areas inspected, violations or deviations were not identified.

Two Inspector Followup Items (IFI) were identified pertaining to concrete expansion anchor design criteria (paragraph 3.0) and the technical adequacy of the CONAN computer program (paragraph 3.0). Two Unresolved Items (UNR) were

Enclosure

identified regarding the licensee's corrective action pertaining to a potential error in design of Unit 3 structural steel platforms (paragraph 5.0) and a potential error in a design calculation (paragraph 7.4).

The inspectors concluded that the overall quality of the pipe support calculations reviewed was good. The licensee's quality assurance program and employee concerns program in the area of design calculations have been effective. The licensee's employee concerns programs is rated a strength.

REPORT DETAILS

1. Persons Contacted

Licensee Employees

S. Brown, Modifications Engineer
R. Cutsinger, TVA Chief Civil Engineer
J. Davenport, Licensing Engineer
*J. Glass, Acting Lead Civil Engineer
K. Gromek, Civil-Structural Engineer
L. Jones, Concerns Resolution Staff
*E. Machon, Site Vice President
*J. McCord, Civil-Structural Engineering Supervisor
L. Madison, Lead Civil Engineer, Unit 3
*E. Preston, Plant Manager
*J. Valante, Unit 3, Recovery Engineering Supervisor
*R. Wells, Compliance Licensing Manager
*H. Williams, Site Nuclear Engineering Manager

Other licensee employees contacted during this inspection included engineers, technicians, and administrative personnel.

Other Organizations

Bechtel Power Corporation

D. Eshleman, Site Quality Engineer
V. Kapoor, Engineering Group Supervisor
L. Lushbough, Chief, Plant Design and Civil Engineering
D. Palmer, Civil Project Group Supervisor
D. Strodman, Quality Assurance, (telephone conversation)

NRC Resident Inspectors

*L. Wert, Senior Resident Inspector
J. Munday, Resident Inspector
R. Musser, Resident Inspector
G. Schnebli, Resident Inspector

*Attended exit interview

2.0 Review of Quality Assurance Implementing Procedures for Control of Design Activities - Unit 1, 2, 3, (37550)

The inspectors reviewed the Nuclear Engineering Procedures (NEP) and Standard Engineering Procedures (SEP) listed below which specify the licensee's requirements for control of design activities. Acceptance criteria utilized by the inspectors appear in FSAR Appendix D, the TVA Quality Assurance Program, and ANSI 2.11. Procedures reviewed were as follows:

NEP 2.3, Control of Changes to Licensing Documents, Revision 0, November 30, 1987

NEP 3.1, Calculations, Revision 2, February 28, 1992

NEP 3.2, Design Input, Revision 1, March 13, 1992

NEP 3.8, Computer Software System Development, Procurement, Qualification and Control, Revision 1, December 9, 1991

NEP 5.1, Design Output, Revision 3, April 20, 1992

SEP 9.1.1, Control of Engineering Procedures, Revision 0, August 25, 1992

SEP 9.1.2, Training of Personnel, Revision 1, May 28, 1993

SEP 9.1.5, Oversight and Monitoring, Revision 0, November 26, 1993

SEP 9.5.4, Design Standards and Guides, Revision 0, September 7, 1993

SEP 9.5.5, Engineering Computer Codes Development/Use, Revision 0, October 12, 1993

SEP 9.5.6, Design Verification, Revision 0, September 8, 1992

The above procedures specify the requirements for control of design activities and include the following: design inputs, design processes for control of calculations, drawings, and specifications, interface controls, design verification, design change control, corrective action, qualification and control of computer software, and document control.

No Violations or Deviations were identified.

3.0 Review of Pipe Support Calculations - Unit 2 and 3 (37550)

The inspectors reviewed portions of the pipe support calculations listed below for thoroughness, clarity, consistency, adherence to design criteria, and accuracy. Acceptance criteria utilized by the inspectors included those procedures listed in paragraph 2.0, above, and the following documents:

Design Criteria	BFN-50-C-7107, Revision 6,	Design of Class 1 Seismic Pipe and Tubing Supports
Design Criteria	BFN-50-C-7100, Revision 8,	Design of Civil Structures
Civil Design Standard	DS-C1.7.1, Revision 5,	General Anchorage to Concrete

Civil Design Standard	DS-C1.7.3, Revision 1,	Concrete Anchorage Application of Baseplate II
TVA General Engineering	Specification G-32, Revision 19,	Bolt Anchors Set in Hardened Concrete
TVA General Engineering	Specification G-66, Revision 4,	Requirement for the Use of Undercut Anchors Set in Hardened Concrete During Installations, Modification, and Maintenance
Lead Civil Engineering Instruction	BFEP-CI-C5, Revision 1,	Interface Review and Evaluation of Attachments to Civil Features

During review of the calculations, the inspectors also utilized the users manuals, as required, for the following computer programs: the FAPPS program for the structural member analysis, including member connection weld analysis, the Baseplate II program for flexible base plate and concrete anchor analysis, and the CONAN program for analysis of anchor bolt spacing violations.

The licensee uses the CONAN computer program to calculate the allowable anchor loads for anchors which are located near other anchors at distances less than those specified in TVA Specification G-32. This program was developed by the licensee in the early 1980's and is used throughout TVA. The inspectors reviewed the use of the CONAN program during previous inspections, and questioned the theory used to distribute concrete capacity to adjacent anchors (See report number 50-259, 260, 296/91-11). During the current inspection, the inspectors reviewed the theoretical manual for the CONAN program, and reviewed the computer software qualification manual. The inspectors questioned the method used to distribute and divide the overlapped failure cone areas to adjacent anchors, and its relationship to the straight line distribution, or to other methods currently approved by NRC. The licensee will perform a comparison of the results from CONAN with current industry practice to a program that has been approved by NRC for evaluation of allowable anchor capacities. Review of this data in a future inspection was identified to the licensee as Inspector Followup Item (IFI) 259, 260, 296/94-29-01, Review of CONAN Concrete Capacity Data.

The inspectors reviewed the pipe support design calculations listed in the table below:

Calculation No.	Rev. No.	Support No.
CD-Q2001-883889	2	2-478400S0157
CD-Q2010-882391	4	2-47B465H0023
CD-Q2010-882397	2	2-47B465S0005
CD-Q2074-882471	0	2-47B452H0097
CD-Q2014-892981	0	2-47B452H0191
CD-Q3067-921364	1	3-47B451-854
CD-Q3075-921591	2	3-47B458-143
CD-Q3002-920720	0	3-47B553-43
CD-Q3002-920737	0	3-47B553-58

During review of calculation number CD-Q2010-882397, Revision 2, the inspectors found that the pipe support drawing, number 2-47B465S0005, corresponding to this calculation, had been voided. The licensee issued Revision 3 to this calculation to void the calculation since the drawing had been voided, and no field work was to be performed.

The inspectors found two common problems in the calculations: the check of concrete thicknesses based on the anchor bolt embeddment depth to verify the thickness met the design requirements was not documented in the calculations, and the effect of 1 inch construction location tolerance for anchor bolts was not clearly documented in some calculations.

The design criteria requires the concrete thickness to be 2 times the anchor bolt embeddment depth to ascertain that the concrete does not be spall at far side of the anchorage. The concern regarding lack of documentation of the check of concrete thickness verse embeddment depth is in the calculation is discussed in paragraph 7.1, below.

Appendix H of Design Standard DS-C1.7.1 specified the criteria for construction tolerances for installation of concrete anchors. The procedure in Appendix H specifies use of amplification factors to compute maximum anchor loads and baseplate bending stresses. During review of calculation numbers CD-Q3002-920720 and - 920737, the inspectors noted that the licensee used an alternative method for four-bolt baseplates to account for construction tolerances in which the anchor locations were varied. However, the alternate method is not included in the Design Standard. The inspectors questioned whether the alternate method is the worst case conditions. This method relocates three anchors by moving them away from the attachment a distance of one inch in two directions, while the remaining anchor is moved inward a distance of ½ inch in two directions toward the attachment. The licensee provided some sample calculations to the inspectors which indicated that the alternate method was a true worst case condition. However, the licensee will provide some additional information to the inspectors for review that documents the alternative method as the worst case condition. The inspectors also discussed the need to revise the Design Standard to include the alternative method and the need to include design methods to account for tolerances for six bolt baseplates and other conditions in Design Standard DS-C1.7.1. This problem was

identified to the licensee as Inspector Followup Item 259,260, 296/94-29-02, Design Methods to Consider Construction Tolerances for Anchor Locations.

Overall, the inspectors concluded that the calculations were technically adequate and complied with the licensee design criteria and QA Program.

No violation or deviations were identified.

4.0 Review of Audits and Assessments of Bechtel Design Activities - Unit 3 (37550)

The inspectors reviewed the results of design audits performed by Bechtel QA engineers and the results of Technical Assessments performed by TVA engineers. The design audits were performed by the onsite Bechtel Quality Assurance organization in accordance with Bechtel's Quality Assurance program. The Technical Assessments were detailed reviews of the Bechtel design calculations performed by TVA engineers. The purpose of the Technical Assessments was to verify that the Bechtel calculations were accurate, complied with the design criteria, and complied with TVA criteria for format and content. The Technical Assessments were performed on design calculation from January 1992 through the Summer of 1992. The Technical Assessments were discontinued when calculation reviews were included as part of the approval process for Design Change Notice packages. The QA Audits were performed throughout the program and still continue.

Bechtel QA Audit findings were reported as Corrective Action Reports (CARs). The inspectors reviewed the CAR Log and selected CAR numbers BF3-025, BF3-033, BF3-036 and BF3-049 for detailed review. A summary of the CAR findings and corrective actions follows:

- CAR BF3-025, which was initiated on November 7, 1991, involved administrative and minor technical errors in civil, mechanical and electrical calculations. None of the errors affected the technical adequacy of the calculations. That is, the output/conclusions of the calculations were not changed by the errors. The cause of the errors was attributed to inattention to details by the calculation checkers, lack of familiarization of the checkers and originators with Browns Ferry calculation requirements, or lack of adequate justification (explanation) in the calculations to define clearly assumptions and engineering logic used in the calculations. Corrective actions to disposition the CAR included additional training of design engineers and checkers in all disciplines in which each group was made aware of the audit findings. The training also emphasized the importance of the checking process and the need to pay attention to details. Bechtel Engineering also formed a team to examine the design calculation process, and identify areas where the design process could be improved. This team was called the Commitment to Continuous Improvement Team. The inspectors reviewed the records

documenting the additional training on the audit findings and on the need to pay attention to details when checking calculations. The inspectors also reviewed the resolution of the individual comments/errors identified on the various calculations reviewed during the audits. The corrective actions included revising the calculations as required to correct the errors. The inspectors concurred with the actions to resolve/correct the errors. The inspectors also concurred with the conclusion that the errors did not affect the output/conclusions of the calculation. CAR BF3-025 was closed out on August 6, 1992.

- CAR BF3-033 was initiated on January 17, 1992. This CAR involved administrative errors which were identified on 25 of 28 civil calculation packages when the calculations were submitted to the document control center for filing as QA records. The errors involved the incorrect completion of the Calculation Cross Reference Information System (CCRIS) computer data input form. Requirements for CCRIS are stated in TVA procedure BFEP PI 87-76, Implementation of the Calculation Cross Reference System for Browns Ferry Nuclear Plant. A subsequent review of 49 additional calculations disclosed that 29 of them contained similar type of CCRIS related discrepancies. The type of errors were administrative and had no effect on the technical content of the calculations. The cause of the errors was attributed to lack of training or knowledge of engineering personnel to accurately complete the CCRIS data sheets. Bechtel engineering developed a training program on CCRIS and trained all engineering personnel on CCRIS. The inspectors reviewed the training module and reviewed the records documenting the training. The inspectors concluded that this CAR was not similar to CAR BF3-025 and had no impact on the completed calculations. This CAR was closed on April 14, 1992.

- CAR BF3-036 was initiated on January 29, 1992. This CAR identified errors in seven of nine Civil design calculation reviewed. Three of the errors were technical, but had no impact on the final conclusions of the two calculations they affected. The remaining errors were administrative. Examples of the administrative errors were missing signatures, listing incorrect references in the calculations, incorrect revision numbers of references, incorrect page numbers, etc. The cause of the errors was attributed to inattention to details and the fact that there was a delay in finalizing five of the calculations from the time the originator and checker had signed off in the calculations. The calculations had been on hold for several months until the packages were approved and issued by Bechtel Engineering. In the interim (several months) between completion of the checking of the calculations and final approval, some of the revision numbers changed for references and computer programs. These were the cause of some of the administrative errors. The errors did not affect the accuracy of conclusion of the calculations. These

types of errors were similar to those documented in CAR BF3-025. MCAR BF3-002, discussed below, was issued due to failure to initiate timely corrective action to resolve the problems identified in CAR BF3-025.

Corrective actions to disposition CAR BF3-036 included retaining of civil and plant design engineers. The calculations were also revised to correct the errors. Additional corrective actions also included those in response to MCAR BF3-002. This CAR was closed on June 19, 1992.

- MCAR BF3-002 was initiated on February 18, 1992, because corrective actions in response to CAR BF3-025 were ineffective and not timely, resulting in CAR BF3-036. The MCAR, which is a Management Corrective Action Report, is a corporate level CAR which is addressed by Bechtel Corporate Management. The recommended corrective actions to disposition the MCAR were to identify and determine the reasons why the Bechtel Browns Ferry project office had not been effective in resolving CAR BF3-025, perform a root cause analysis, and identify short term and long term corrective actions. Bechtel management determined that the cause of the recurring problems, regarding errors in calculations documented in CAR BF3-036, was inadequate corrective action to resolve CAR BF3-025. The corrective actions for CAR BF3-025 did not focus sufficiently on the changes needed to eliminate these types of errors. The corrective action to disposition the MCAR included the following: Development of a checker's checklist for calculations directed at improving the checker's performance, review of calculations within each group prior to issuance using an administratively oriented checklist to detect an eliminate the types of previously identified errors, trend and evaluate errors identified in calculations, revise training on calculations to improve performance of originators and checkers, and conduct additional training for all design engineers.

The root cause of MCAR BF3-002 was determined to be the failure of Bechtel Engineering management to communicate the importance of administrative review and checking of design calculations and to instill the necessity of sensitivity to these issues to their employees. Bechtel management also failed to recognize the urgency and importance for a timely response to the issues, and subsequently, the necessary emphasis was not stressed to ensure that timely corrective action was implemented to address the calculation errors. Short term corrective actions included meeting with engineering personnel to stress the importance of quality, development of a check list to be used by checkers, and placement of additional emphasis on quality during the orientation preventative for newly assigned personnel to Browns Ferry. Long term corrective actions included additional training which addressed examples of problems recently identified during ongoing audits and other reviews of calculations, monthly project

management meetings to review the quality of performance on the project and various other programs which emphasized ownership of calculations and design work, and the need for quality. The MCAR was closed on November 13, 1992.

- CAR BF3-049 was initiated on April 27, 1992, concerned a violation of the AISC minimum weld size requirements in calculation number CD-N0070-921797. This calculation covered design of non-safety related pipe supports. The fillet weld size designated in the calculation for connection of a support member to the support baseplate was 1/16 of an inch smaller than the minimum fillet weld size specified in the AISC Specification, based on the thickness of the members joined. However, the stresses in the weld were less than the code allowable values. Calculation CD-N0070-921797 was in the first DCN package issued for Unit 3 which had pipe support design work. Corrective actions to disposition this problem was to revise the calculation affected, and review of other completed Unit 3 pipe support calculations to identify and correct any minimum weld size violations. Training was also conducted for all pipe support personnel to discuss this problem and other QA audit findings. The minimum weld size requirements were emphasized during the training. The inspectors reviewed the training records for the pipe support engineers and reviewed a sample of the Unit 3 pipe support calculations and verified weld sizes specified in the completed design complied with AISC minimum weld size requirements. CAR BF3-049 was closed on June 2, 1992. The inspectors concluded that the problem identified in this CAR had little or no safety significance. The licensee's minimum weld size requirements were previously reviewed by the inspector during an inspection documented in NRC Inspection Report number 50-259, 260, and 296/94-04.

In addition to the QA Audits discussed above, licensee engineers conducted a series of Technical Assessments of the Bechtel design calculations during the same time period. The Technical Assessments were performed in accordance with TVA Restart Project Procedure RPP-9.2, Technical Assessment Program, Revision 1. The findings from Technical Assessments were classified as follows: Discrepancy - related to technical or quality requirement; a concern - an enhancement or improvement to the calculation, not necessarily a deficiency, a clarification, i.e., better explanation; or observation. The inspectors reviewed the results of the Technical Assessments. A summary follows:

- Assessment CE-013 was conducted January 7 to March 6, 1992. The assessment was performed on 15 calculations and 14 drawings. The assessment resulted in 85 comments on the calculations and 41 comments on the drawings. The inspectors reviewed the assessment. The majority of the comments on the calculations involved administrative type of issues similar to those addressed by CAR BF3-025, 033, and 036, and MCAR BF3-002. None of the comments

resulted in changes to the output/conclusions of the calculations. The comments on the drawings were primarily constructability type issues, not technical errors. CE-013 was never formally issued since the 15 calculations reviewed during the assessment, although they had been through the checking process, had not yet been approved and issued by Bechtel. However, the comments were furnished to Bechtel and they were incorporated into the calculations and drawings.

- Assessment CE-015 was performed May 6-15, 1992, and involved a review of 11 approved calculations. TVA issued ten findings in this assessment was classified as a concern and identified several issues which addressed individual calculations. The inspectors reviewed assessment CE-015. The majority of the issues involved administrative type comments. None of the findings resulted in changes to the output/conclusions of the calculations. A nonconformance, finding investigation report (FIR), number FIR 92057 was issued to document and disposition the concerns. Corrective action to disposition the FIR involved review of all plant calculations issued prior to May 10, 1992, to determine if similar errors existed in other calculations.

- Assessment CE-017 was performed February 4 to March 13, 1992, on the stress analysis for the CRD piping inside the drywell. One concern was identified on calculation CD-Q3085-910603. The concern involved administrative issues. Overall the assessment was rated as satisfactory, but the reviewers felt the documentation contained within the calculation needed clarification and updating.

- Assessment CE-020 was performed from February 10 to March 7, 1992, on pipe stress calculations related to the long term torus integrity program. The inspectors reviewed the assessment. The licensee identified one finding, FIR number BF FIR 920031, four concerns, and two clarifications. The four concerns involved two technical issues and two administrative issues. The FIR involved failure to evaluate low energy lines under pipe rupture criteria BFN-50-C-7105. This was due to a misunderstanding of requirements for Unit 3 restart, and the difference from the Unit 2 restart effort. For Unit 2 piping systems, low energy piping was evaluated for pipe rupture after restart. Evaluation of low energy piping for rupture will be performed prior to Unit 3 restart. Corrective actions to disposition this FIR included revising the one Unit 3 stress calculation which had been issued, reviewing and revising, as required, in process stress calculations, and training of pipe stress engineers to clarify the requirements for pipe rupture analysis. The FIR was closed on March 26, 1992.

- Assessment CE-040 was performed from April 6 to August, 1992, on various pipe support design calculations for the 79-02/79-14 programs. The inspectors reviewed the assessment which resulted in identification of 11 concerns and eight clarifications. The inspectors review the 11 concerns, which included six technical and five administrative issues. None of the concerns affected the output/conclusions of the calculations.

The inspectors discussed the overall Technical Assessment results with licensee engineers. Licensee engineers stated that, although the findings from the Technical Assessments did not affect the output/conclusions of the calculations, the type errors found were indicative of failure to pay attention to details and sometimes resulted in calculations which were incomplete and did not comply with TVA procedural requirements. Many of the errors found during the Technical Assessments were repetitious.

The inspectors concluded that the licensee's QA program and the Technical Assessment were effective in identifying errors in the calculations. The errors had little or no safety significance.

No violations or deviations were identified.

5.0 Corrective Action Program

The licensee's corrective action program is implemented by TVA procedure SSP-3.4, Corrective Action Program. This procedure established the processes and requirements for documenting and resolving nonconformance on Problem Evaluation Reports (PERs). The inspector reviewed the PER log for the civil discipline in Nuclear Engineering. The log includes items identified by Bechtel, TVA engineering, and other organizations which involved civil design activities. During review of open PERs, the inspector noted that Unit 3 PER number BFPER 940097, initiated in May 1994 addressed a possible design deficiency in the design of Unit 3 drywell platform structural steel beams. The item involved the methodology used to address the design of cover plates added to strengthen frames, and the theoretical cutoff points used in the structural analysis. Preliminary findings indicated twelve drywell subframe assemblies required additional modifications because of this problem. The inspectors questioned licensee engineers regarding the application of this problem to the design of the Unit 2 platform steel. The inspectors noted that as of the inspection dates, a PER had not been identified to address this problem for Unit 2. Pending further review by NRC, this issue was identified to the licensee as Unresolved Item 260/94-29-03, Corrective Action to Resolve Potential Error in Design of Cover Plates on Unit 2 Platform Steel.

No violations or deviations were identified.

6.0 Inspection of Pipe Supports

The inspectors performed a walkdown inspection of Unit 3 support number 3-47B458-143 to determine if the support was constructed in accordance with design requirements. The support had been installed under DCN number W18699A. The inspectors examined the following items during the inspection: member sizes, baseplate sizes, weld sizes, snubber size and setting, and anchor bolt type and diameter, projection, length (as indicated by end stamp) and spacing/location. The inspectors verified the support had been installed in accordance with the design requirements specified on drawing number 3-47B458-143, Revision 1, and FDCN number F29901A. No discrepancies were identified. The inspectors also reviewed calculation number CD-Q3075-92191 which was initiated to design the new support. Revision 2 of this calculation incorporated DCN F29901A. The inspectors verified that the changes on the DCN were approved in Revision 2 of the calculation.

No violations or deviations were identified.

7.0 Licensee Action on Previous Inspection Findings

(Closed) Inspector Followup Item 259,260,296/94-10-01, Review of Action to Resolve Employee Concerns Regarding Pipe Support Calculations

This Inspector Followup Item (IFI) resulted from review of the licensee's employee concerns program. The inspectors reviewed the licensee's response to the employee concerns and evaluated the disposition of concerns on the pipe support calculations, to determine if the issues were generic (i.e., affected other calculations), and to verify that correction actions were adequate and completed. The inspectors discussed the concerns with licensee engineers and reviewed the calculations affected by the concerns documented in Employee Concern ECP-93-BF-161-F1. An assessment of the concerns is documented in a Bechtel letter from R. W. Jackson, Project Engineering Manager, Bechtel to J. E. Maddox, TVA, dated August 25, 1993, Subject: Unit 2 Calculations. The disposition of 31 questions or concerns on calculation numbers CD-Q2074-894001, Revision 3; CD-Q2074-894002, Revision 2; and CD-Q2074-89005, Revision 3, plus several additional generic concerns on calculations is documented in a TVA memorandum from J. Rupert, Site Engineering, to L. Jones, TVA Concerns Resolution Staff, dated September 11, 1993, Subject: ECP-93-BF-161-F1, Unit 2 Operability Impact Determination. The disposition of 14 additional concerns relating to Calculation number CD-Q2064-871385, Revision 9, is documented in Attachment A to a Bechtel letter dated August 23, 1994, to L. Jones, TVA Concerns Resolution Staff, From R. McIndoe, Bechtel. The concerns are summarized below:

7.1 Calculation No. CD-Q2074-894001, Revision 3

Concerns:

There were seven concerns pertaining to this calculation. The concerns included specifying a weld size less than the minimum weld size required by the AISC code, not updating employee concern checklist for Revisions 1 and 2 of the calculation, incorrect input in the CONAN computer program, not checking the concrete thickness for the anchor bolt embeddment limitations, not checking the actual base plate thickness in the anchor design, not considering the anchor bolt edge distance, and the possibility that structural attachment loads (SAL) were not transmitted to the Civil Structural Integrated Group for use in the civil structure design.

Resolution:

For the anchor bolt edge distance concern, the model for CONAN computer program had included the pipe sleeve information. However, the calculation did not check the concrete anchor shear capacity. The licensee used a hand calculation to show the concrete capacity for shear is acceptable. The licensee reviewed 64 calculations for this concern and had not found out any other supports violated the minimum edge distance requirement.

For the minimum weld size violation, review of the calculation showed that the allowable stress requirements were met. Paragraph 1.4.5 of BFN-50-7107 states that AISC minimum weld size requirements need not be considered provided all other stress requirements are met. The employee concern checklist was an administrative requirement which was not applicable to Revision 1 or 2 of the calculation. Review of the CONAN input showed that the proper data was used, as defined as an alternative application in the Conan manual. The attachment thickness is less than the maximum permitted. Review of the calculation also showed that the correct SALs were used, however, this was not clearly documented in the calculation. The calculation was revised to add the SALs.

Review of various calculations showed that the check of member thickness versus anchor embeddment depth is not clearly documented in many calculations. Therefore, the inspectors requested that the licensee review anchor bolt embeddment depth against the concrete thickness, especially in the thinner slabs or walls in safety related structures. The licensee sent two design engineers to walk-through the areas with thin slabs, which included Reactor Building floor elevations 565 feet and 593 feet, since significant portions of these floors consisted of 12 inch thick slabs and because the likelihood of large bore piping attached to those slabs is higher than in other plant areas. Five supports were identified during the walk-through for additional review. The five supports in Unit 2 were supports 2-47B450H0044, 2-47B451S0138, R10, R7, and 2-47B450R0026. Except for support 2-47B450R0026, the others did not require special evaluation because either the concrete thickness was more than twice the anchor bolt embeddment depth or

documentation for anchor group pullout was provided in the calculation. For support 2-47B450R0026, the maximum applied load for all anchor bolts at tension was found to be less than 30 percent of the combined allowable load on the anchor bolts and, therefore, the slight effective concrete area reduction will have no significant effect. The anchor bolt allowable load is still controlled by anchor steel capacity, not anchor bolt group failure. Therefore, this support was acceptable. The licensee revised the support calculation CD-Q2023-884096, Revision 6 to document this evaluation for the anchor bolts.

The licensee also reviewed the Unit 3 calculations for the check of slab thickness versus anchor embeddment depth. The licensee randomly selected several calculations for review which were originated between June, 1992, to September 1994. The licensee's review showed that the Unit 3 calculations properly document the member thickness versus anchor embeddment.

The inspectors also reviewed some randomly selected Unit 3 calculations and concluded that the check of slab thickness versus anchor embeddment depth was properly documented in three calculations. After the review of the Unit 2 calculations discussed above, and review of randomly selected Unit 3 calculation, the inspectors concluded that the issue of documentation of concrete thickness versus anchor embeddment depth is resolved.

The inspectors concluded that the licensee's resolution of the above concerns were acceptable.

7.2 Calculation CD-Q2074-894002, Revision 2

Concerns:

Three concerns were raised on this calculation. The concerns included prying effect on the base plates, use of the minimum depth value for anchor bolt qualification instead of the effective depth value in the Conan input, and not updating the conclusion sheet when revising calculations.

Resolution:

Prying action was not documented in this calculation and is not required because the base plate is rigid. The Conan program internally adjusted the minimum depth value to arrive at the effective depth. Since the calculation conclusions did not change, it was not necessary to revise the conclusion sheet. The inspectors considered the licensee's resolution to the concerns to be adequate.

7.3 Calculation CD-Q2074-894005, Revision 3

Concerns:

Twenty-one concerns were raised for this calculation. The concerns included questions about the licensee's handling of revision of calculations and drawings, administration procedures, documentation of the AISC Code edition in the calculation, minimum weld size requirements, interaction ratio greater than 1.0, temperature effect on allowable stress values, use of incorrect allowables stress values, incorrect base plate thickness, member self-excitation values, the minimum effective throat for welds, inconsistency in the applied load on the same anchor in the two different calculations, not rechecking deflection when the load increased, etc.

Resolution:

Many of these concerns were addressed in the calculations listed above. More than half of the concerns were related to the administrative processes or procedures and have no impact on safety. Review of the concern on the incorrect allowables used or the interaction ratio exceeding 1.0 showed that the values in the examples were approximately two percent over the actual allowables. The two percent applied load over the allowable loads were considered to be acceptable since the normal pipe support design and calculations contain the conservative applied loads. The licensee reviewed 64 additional support calculations to determine if other cases existed where applied loads exceeded allowable loads. No other examples were identified.

In the response to the concern regarding the need to recheck deflection when the support load increased, the licensee calculated that the new deflection, with a load factor increase of 22.1 percent, was 0.0116 inches which was less than the maximum allowable deflection of 0.125 inches. The inspectors noted that a typographical error in the Bechtel letter stated that the revised deflection would be 0.116 inches.

The inspectors considered that the resolution of the concerns for this calculation were acceptable.

7.4 Calculation CD-Q2064-871385, Revision 9

Concerns:

Fourteen concerns were raised on this calculation. The concerns included the use of wrong allowables, use of incorrect values in portions of the calculation, using an incorrect value for effective throat of a flare bevel weld, no cross reference for weld calculation due to the new loads, arithmetic error, the process of handling the removed sheets and added sheets for the same page number in the same revision, lack of explanation in the calculation for considerations for the applied forces in the weld qualification and the concrete edge distance, no checker's signature in the copy of DCA attached to the

calculation, drafting errors on drawings, and failure to remove redundant sheets from the calculation. The individual also raised three general concerns about the procedures or design criteria. These three concerns will be included in the general concern, Section 6 below.

Resolution:

The inspectors reviewed the response to the above concerns and considered the resolution to be adequate and acceptable.

The incorrect allowable stress value 0.532 Fy versus 0.52 Fy resulted in a two percent error in the weld size computation. However, there was sufficient margin in the weld size specified and the error had no significance. An incorrect value was used in a denominator of an equation on page 60.2 of the calculation. However, the resulting answer was correct. Therefore, this error must have been detected previously and someone forgot to change the incorrect number in the denominator on the original copy of the calculation. The use of the incorrect value for the effective throat size of a flare bevel weld did not affect the output of the calculation. The error was actually in the conservative direction. The arithmetic error was similar to that discussed above regarding the incorrect value used for the denominator. The result of the computation was correct, i.e., it was obvious the correct values were used. The calculation was revised (Revision 10) to correct these discrepancies. The remaining comments concerned administrative issues which had no safety significance.

During the review of this calculation, the inspectors found that in the calculation for qualifying the maximum anchor bolt loads and maximum base plate stresses, the amplification factor specified in Appendix H of Civil Design Standard DS-C1.7.1 was not used to account for the maximum loads due to the anchor 1 inch movement allowed by the construction tolerances. This calculation had been revised up through Revision 10. The inspectors were unable to determine if this was an error, or if the anchor/base plate loads were based on actual as-built anchor locations. The licensee will perform an indepth review of the calculation to provide information to the inspectors on the use of the amplification factors. Pending further review by NRC, this problem was identified as Unresolved Item 296/94-29-04, Use of Amplification Factors for Anchor Bolt Loads and Base Plate Stresses.

7.5 Common Concerns

In addition to the concerns discussed above, several concerns were identified which the Concerns Resolution Staff classified as generic in nature, or as general technical concerns which were applicable to a large number of calculations. The licensee classified these concerns as Common Concerns and responded to these on a generic basic. The inspectors reviewed the licensee's responses to these concerns. The

inspectors also reviewed the employee concern file for ECP-93-BF-161-F1 and verified that the licensee addressed all the issues/comments raised by the individual. A discussion of the common concerns and the resolution of each follows below:

7.5.1 Bechtel Engineers in San Francisco Office Used Incorrect Allowable Values for Undercut Anchors.

Concern:

Unit 2 pipe support design was performed by Bechtel engineers in the Bechtel San Francisco Office. An individual claimed he had indirect knowledge that the Bechtel engineers in the San Francisco Office used increased allowable stress values for shallow undercut anchors for seismic conditions, contrary to TVA procedures.

Resolution:

Shallow undercut anchors were initially authorized for use at Browns Ferry in May 1989. The design criteria issued at that time initially authorized normalization of loads which effectively permitted increasing the allowable loads for seismic loading conditions. In May 1991 TVA revised their design criteria to state that load increases would not be acceptable for shallow undercut anchors. The licensee determined that 56 supports had been designed using shallow undercut anchors prior to the change in the design criteria. The results of the licensee's investigation, which is documented in design calculation CD-Q0999-94018 showed the anchors meet current design criteria. No support modifications were required.

7.5.2 Change/Revisions to Calculations

Concern:

An individual claimed that changes were made to some Unit 3 pipe support calculations without notifying the persons who had prepared the calculations. The individual claimed that some changes were made in error, or were not denoted as changes. The individual could not give any specific examples to the Concerns Resolution Staff.

Resolution:

The licensee randomly selected four calculations for review to determine if the calculations were technically correct. The review showed the calculation were technically adequate. The inspectors also reviewed a large number of Unit 3 calculations. There was no evidence of unauthorized or undocumented changes being made to any of the calculation. Contrary to this concern, the inspectors concluded that the changes to calculations were well documented within the calculations as calculation revisions. The identification of the originator, checker, and reviewer are documented in the calculations in accordance with the licensee's design control procedures and NRC requirements. The

inspectors noted that each calculation sheet showed the identification of the checker and reviewer. The only exception to this was in some cases for Revision 0 issues of calculations where only one individual originated a calculation and one other individual checked the calculation. In these cases the identification of the checker/originator are not shown on the individual calculation pages but are listed only on the calculation cover sheet. This is in accordance with the licensee's procedures.

7.5.3 Changes to Pipe Support Stress Calculations

Concern:

Changes to pipe stress calculations were not being communicated to the pipe support group, and therefore, were not being incorporated into pipe support calculations.

Resolution:

Two violations were issued by the NRC for failure of the licensee to update pipe support calculations when the stress calculation were revised and pipe support loads changed. These violations were identified during inspections documented in NRC Inspection Report number 50-259,260,296/92-38 and 93-26. The violations were closed after the inspector verified the licensee's corrective actions which included review of a large number of pipe support calculation to ascertain that the correct loads were used for support design.

7.5.4 Use of Marked Up Drawings as Design Input Documents

Concern:

Pipe support engineers were required to use marked up isometric drawings which showed pipe support locations. These marked up drawings were used as design input documents. An individual claimed that in August 1993 some engineers found errors on the marked up drawings for support numbers 1381 and 1382 for System 74 (RHR).

Resolution:

The marked up isometric drawings were prepared by one group of engineers to locate accurately pipe supports in reference to column lines and elevations. The reference dimensions were used in initial pipe support design. Due to field conditions and resolution of constructibility comments, minor corrections had to be made to some support locations/dimensions. These changes were coordinated with piping stress engineers, and stress calculations were revised if required. An accurate support location drawing was included in the final DCN package. Changes to issued DCN packages are documented as FDCNs.

7.5.5 Evaluation of Boundary Anchor Between Seismic and Non-Seismic Piping

Concern:

The load combination used in the evaluation of the boundary anchor between the seismic and non-seismic anchor was different for Unit 2 and Unit 3 piping. For Unit 2 piping, plastic torsion from the seismically analyzed piping was included in the anchor design. Plastic torsion was not required to be considered for Unit 3 piping. The concern was that the boundary anchor evaluations may be unconservative for Unit 3.

Resolution:

TVA General Design Criteria BFN-50-C-7107 requires plastic moment in each of two orthogonal local bending directions to be combined independently with the loads from the seismically analyzed side. It is not necessary to consider plastic torsion with seismic torsion as a separate load case. Inclusion of plastic torsion as an additional load case would be more conservative, however, it is not required by the design criteria. The design criteria, including load combinations used in the analysis, was approved by the NRC Office of Nuclear Reactor Regulation, as documented in NUREG-1232, Safety Evaluation Report for Browns Ferry Unit 2 Restart.

7.5.6 Cumulative Effect of Load Increase on Civil Structures, including Foundations

Concern:

An individual questioned whether the cumulative effect of load increases were considered in design of civil structures, e.g., floors, walls, columns, and foundation. The concern was that piping loads had significantly increased after the piping was reanalyzed, and civil structures may be overloaded.

Resolution:

A Condition Adverse to Quality Report (CAQR) number BFP 880359 was initiated on May 13, 1988, which identified the inadequate evaluation of accumulated loading effects on civil structures. This was identified as a Unit 2 Restart issue. The inspectors reviewed the CAQR, and Lead Civil Engineer Instructions, BFEP-CI-C5, Interface Review and Evaluation of Attachments to Civil Feature, and BFEP-CI-C8, Interface Review and Evaluation of Attachments to Civil Features (Prior to Restart of Unit 1, 2, and 3) which were issued as part of the corrective action for the CAQR. The issue was also reviewed by the NRC Office of Nuclear Reactor Regulation prior to Unit 2 restart. The disposition of the CAQR and resolution of this issue was acceptable.

7.5.7 Applicability of Concerns to Other calculations

Concern:

Concerns listed in paragraphs 7.1 - 7.4 above, may be applicable to other calculations.

Resolution:

The specific concerns listed in paragraphs 7.1 - 7.4 had little or no safety significance. Most of these type of concerns have been addressed in the licensee's Technical Assessments and Quality Assurance Audits discussed in paragraph 4.0, above.

7.5.8 Review of Calculations for Additional Discrepancies

Concern:

An individual stated that the concerns expressed on calculation numbers CD-Q2074-894001, -894002, and -894005, discussed in paragraph 7.1 - 7.3, above were only based on a cursory review.

Resolution:

The specific concerns on these calculations have been reviewed and addressed by the licensee. These calculations, which apply to Unit 2 pipe supports, were completed offsite in the Bechtel San Francisco Office. Therefore, the concerns are not applicable to the current Unit 3 pipe support design. The inspectors performed a detailed review of these calculations and found no significant discrepancies. A few other minor errors were identified but these do not affect the output/conclusions of the calculations.

7.5.9 Qualification of Individuals Approving Calculations

Concern:

An individual recommended that at least 25 calculations approved by two individuals be checked thoroughly again since these individuals may not be familiar with the design criteria, and were not qualified. The inspectors noted in review of the employee concerns file that the concerned employee named two other Bechtel supervisory engineers who he also suspected may not be qualified to approve pipe support designs.

Resolution:

The licensee concluded that since the calculations in question were included in the scope of other reviews (audits and technical assessments), no further action or review was warranted to resolve this concern. The inspectors concurred. The inspectors also reviewed the qualification of the Bechtel supervisory engineers whose qualification the concerned individual questioned. The individuals will be listed as

Individuals A, B, C, and D, for privacy reasons. Individual A has a Master's degree in Civil Engineering and more than 22 years of pipe support design experience in the nuclear industry. The individual has held progressively responsible positions with various Architect-Engineer firms and utilities, and has supervised large groups of engineers and pipe support design work on several projects. Individual B has a BS degree in Mechanical Engineering and 24 years of design experience, 17 years of which is in the nuclear industry. This individual was a supervisory engineer on other projects, where he was responsible for pipe support design work. Individual C held a BS degree in Mechanical Engineering and has more that 14 years experience in the nuclear industry. This individual had extensive pipe support design in another projects and seven years of supervisory experience with Bechtel. Individual D has a BS degree in Mechanical Engineering and is a registered professional engineer. He has had more than 12 years of pipe support design experience on several projects and was also a supervisory engineer on several projects where he supervised pipe support design work. The inspectors concluded that the four individuals named by the concerned employee were well qualified to supervise pipe support design work.

7.6 Conclusions:

Employee concern ECP-93-BF-161-F1 documents the licensee's response to an individual who raised 45 concerns on four specific calculations and nine generic concerns common to the pipe support design process. The inspectors concluded that the licensee's resolution/disposition of the concern was adequate. The concerns can be classified into three general areas:

(1) Administrative issues which had no impact on the technical content or conclusions of the calculations.

(2) Minor technical issues which did not change the output/conclusions of the calculations, and therefore, had no safety significance.

(3) Restatement of technical issues which had been previously resolved under the licensee's corrective action program.

The licensee dedicated significant resources to perform a detailed review of the issues raised by the concerned individual. The licensee's resolution of ECP-93-BF-161-F1 demonstrates the effectiveness of the TVA Employee Concerns Program and the commitment of licensee senior management to resolve issues/concern raised by employees. The licensee Employee Concerns Program is rated a strength.

The inspectors also concluded that the licensee's overall involvement in control of Bechtel design activities was good. Procedures for control of design activities are well stated, explicit and understandable, licensee reviews of design activities were timely, thorough, and technically sound, and audits were complete, timely and thorough. The design process was well controlled and verified.

No violations or deviations were identified. IFI 259,260,296/94-10-01 is closed.

8.0 Exit Interview

The inspection scope and results were summarized on December 9, 1994, with those persons indicated in paragraph 1. The inspectors described the areas inspected and discussed in detail the inspection results listed below. Although reviewed during this inspection, proprietary information is not contained in this report. Dissenting comments were not received from the licensee.

IFI 259,260,296/94-29-01, Review of CONAN Concrete Capacity Data, paragraph 3.

IFI 259,260,296/94-29-02, Design Methods to Consider Construction Tolerances for Anchor Locations, paragraph 3.

URI 260/94-29-03, Corrective Action to Resolve Potential Error in Design of Cover Plates on Unit 2 Platform Steel, paragraph 5.0.

URI 296/94-29-04, Use of Amplification Factors for Anchor Bolt Loads and Base Plate Stresses, paragraph 7.4.